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*THE AGE OF SCIENCE.**

As much of the time of those who go forth from this institution to-day has been spent in the study of the sciences, it has seemed to me fitting to ask your attention to some considerations suggested by the phrase, 'This is the age of science.' I do not remember ever to have heard this statement questioned, much less denied, nor do I remember ever to have heard it satisfactorily explained. It sounds simple enough, and does not appear to call for explanation or comment, and yet I think it worth while to examine it a little more carefully than is customary, to see in what sense it is true. For in a sense it is true, and in a sense it is not true. The statement raises two questions which should be answered at the outset. These are: (1) What is science? and (2) In what sense is this the age of science?

First, then, what is science? Surely there can be no difficulty in answering this, and yet I fear that, if I should pass through this or any other audience with the question, I should get many different answers.

A certain lady, whom I know better than any other, has told me that, should she ever be permitted to marry a second time, she would not marry a scientific man, because scientific men are so terribly accurate. I often hear the same general idea expressed, and it is clear that accuracy is one attribute of science according to prevailing opinions. But accuracy alone is not science. When we hear a game of baseball or of whist spoken of as thoroughly scientific, I sup-

* Commencement address delivered at Worcester Polytechnic Institute, June 9, 1904.

pose the idea here, too, is that the games are played accurately; that is, to use the technical expression, without errors.

Again, there are those who seem to think that science is something that has been devised by the Evil One for the purpose of undermining religion. This idea is not so common as it was a few years ago, when the professors of scientific subjects in our colleges were generally objects of suspicion. The change which has come over the world in this respect within my own memory is simply astounding. In general terms an agreement has been reached between those who represent religion and those who represent science. This agreement is certainly not final, but it gives us a *modus vivendi,* and the clash of arms is now rarely heard. Religion now takes into consideration the claims of science, and science recognizes the great fundamental truths of religion. Each should strengthen the other, and in time, no doubt, each will strengthen the other.

Probably the idea most commonly held in regard to science is that it is something that gives us a great many useful inventions. The steam-engine, the telegraph, the telephone, the trolley car, dye stuffs, medicines, explosives—these are the fruits of science, and without these science is of no avail. I propose farther on to discuss this subject more fully than I can at this stage of my remarks, so that I may pass over it lightly here. I need only say now that useful inventions are not a necessary consequence of scientific work, and that scientific work does not depend upon useful applications for its value. These propositions, which are familiar enough to scientific men, are apt to surprise those who are outside of scientific circles. I hope before I get through to show you that the propositions are true.

Science, then, is not simply accuracy, although it would be worthless if it were not accurate; it is not devised for the purpose of undermining religion; and its object is not the making of useful inventions. Then what is it? One dictionary gives this definition: "Knowledge; knowledge of principles and causes; ascertained truth or facts. * * * Accumulated and established knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws, * * * especially such knowledge when it relates to the physical world, and its phenomena, the nature, constitution and forces of matter, the qualities and function of living tissues, etc."

One writer says: "The distinction between *science* and *art* is that *science* is a body of principles and deductions to explain the nature of some matter. An *art* is a body of precepts with practical skill for the completion of some work. A *science* teaches us to know; an *art,* to do. In *art,* truth is a means to an end; in *science* it is the only end. Hence the practical arts are not to be classed among the sciences." Another writer says: "*Science* and *art* may be said to be investigations of truth; but one, *science,* inquires for the sake of knowledge; the other, *art,* for the sake of production; and hence *science* is more concerned with the higher truths, *art* with the lower; and *science* never is engaged, as *art* is, in productive application."

Science, then has for its object the accumulation and systematization of knowledge, the discovery of truth. The astronomer is trying to learn more and more about the celestial bodies, their motions, their composition, their changes. Through his labors, carried on for many centuries, we have the science of astronomy.

The geologist has, on the other hand, confined his attention to the earth, and he is trying to learn as much as possible of its composition and structure, and of the processes that have been operating through

untold ages to give us the earth as it now is. He has given us the science of geology, which consists of a vast mass of knowledge carefully systematized and of innumerable deductions of interest and value. If the time should ever come when, through the labors of the geologist, all that can possibly be learned in regard to the structure and development of the earth shall have been learned, the occupation of the geologist would be gone. But that time will never come.

And so I might go on pointing out the general character of the work done by different classes of scientific men, but this would be tedious. We should only have brought home to us in each case the fact that, no matter what the science may be with which we are dealing, its disciples are simply trying to learn all they can in the field in which they are working. As I began with a reference to astronomy, let me close with a reference to chemistry. Astronomy has to deal with the largest bodies, and the greatest distances of the universe; chemistry, on the other hand, has to deal with the smallest particles and the shortest distances of the universe. Astronomy is the science of the infinitely great; chemistry is the science of the infinitely little. The chemist wants to know what things are made of, and, in order to find this out, he has to push his work to the smallest particles of matter. Then he comes face to face with facts that lead him to the belief that the smallest particles he can weigh by the aid of the most delicate balance, and the smallest particles he can see by the aid of the most powerful microscope, are immense as compared with those of which he has good reason to believe the various kinds of matter to be made up. It is for this reason that I say that chemistry is the science of the infinitely little.

Thus have I tried to show what science is and what it is not. Now let me turn to the second question.

In what sense is this the age of science? In the first place, it is not true that science is something of recent birth. Scientific work of one kind and another has been in progress for ages—not in all branches, to be sure—but nature has always engaged the attention of man, and we may be sure that he has always been trying to learn more about it. The science of astronomy was the first to be developed. Astrology was its forerunner. Then came chemistry in the guise of alchemy. It would be interesting to follow the development of each, and to see how from the crude observations and imaginings of the earlier generations came the clearer and broader conceptions that constitute the sciences, but time will not permit us to enter upon this subject. I can not, however, do justice to my theme without calling your attention to one of the most serious obstacles that stood in the way of the advance of knowledge.

To make clear the nature of this obstacle, it will be best to make a comparison. A child learns a great deal in regard to his surroundings in his earliest years before he goes to school, and without the aid of his parents. He is constantly engaged in making observations and drawing conclusions, and his actions are largely guided by the knowledge thus gained. After a time school life begins, and the child then begins to study books and to acquire knowledge at second-hand. This is an entirely different process from that by which he gained his first knowledge. The latter is natural, the former is artificial. Then, too, he soon discovers that many things he sees call for explanation, and he is led to wonder what the explanation is. If he has a strong imagination, as most children have, he will probably think out some explanation. He finds that he can use his mind, and that this helps him in dealing with the facts in

nature. Now comes the danger. It being much easier to think than to work, the chances are that in trying to find the explanation of things, he will give up the natural method and be satisfied with the products of his imagination. He will gradually give up dealing directly with things, and take to thinking alone. When this stage is reached his knowledge will increase very slowly, if at all.

Whether this picture of the development of a child is in accordance with the facts of life or not, it gives an idea of the mental development of mankind. First came the period of infancy, during which observations were made and much learned. Efforts were early made to explain the facts of nature. We have remnants of these explanations in old theories that have long ceased to be useful. They no doubt served a useful purpose in their day, but gradually one of the most pernicious ideas ever held by man took shape, and I am willing to characterize it as one of the most serious obstacles to the advance of knowledge. I refer to the idea that it is a sign of inferiority to work with the hands. This idea came early and stayed late. In fact, there are still on the earth a few who hold it. How did this prove an obstacle to the advance of knowledge? By preventing those who were best equipped from advancing knowledge. The learned men of the earth for a long period were thinkers, philosophers. They were not workers in nature's workshop. They tried to solve the great problems of nature by thinking about them. They did not experiment. That is to say, they did not go directly to nature and put questions to her. They speculated. They elaborated theories. During this period knowledge was not advanced rapidly. It could not be. For the only way along which advances could be made was closed.

Slowly the lesson was learned that the only way by which we can gain knowledge of nature's secrets is by taking her into our confidence. Instead of contemplation in a study, we must have contact with the things of nature either out-of-doors or in the laboratory. Manual labor is necessary. Without it we may as well give up hope of acquiring knowledge of the truth. When this important fact was forced upon the attention of men, scientific progress began and continued with increasing rapidity. At present the old pernicious idea that a man who does any kind of work with his hands is by virtue of that fact an inferior being—that idea is no longer generally held. But we have not got entirely rid of it. In a recent address I find this reference to the subject: "However the case may have been with what forty years ago was called the education of a gentleman, it seems to me to be one of the services of the scientific laboratory that it has taught to that part of mankind which has leisure and opportunities that manual skill is a thing to be held in honor both as a means for reaching mechanical results, and still more, as a way to train the mind. * * * Fifty years ago many men who called themselves educated were mere untrained, undeveloped children in manual skill, and some of them were proud of their incompetency, for nothing would have more surprised them than an assertion that their inability to help themselves with their hands was a badge of ignorance. * * * While the high character and sterling worth of the medical man has always won respect, their skill in the use of their hands was long held by those who were superior to such weakness to place them beneath the lawyers and the clergymen in the social scale." Recently I came upon this old idea within college walls. In the college connected with the Johns Hopkins University there are several groups of studies which lead to the degree of bachelor of arts.

Group I. is largely made up of the classics, and it is therefore generally called the classical group. I happened once to be dining with a gentleman whose son was a student in Group I. in our college. Our professor of Latin was also present. Turning to my colleague, the professor of Latin, our host, the father of the classical student, exclaimed: 'How those fellows in Group I. look down upon all the others!' I afterwards learned that this feeling undoubtedly existed among the students, those who studied the classics, especially, forming, in their own opinion at least, a well-characterized aristocracy. I have referred to these cases simply for the purpose of showing that the pernicious idea that hand-work is a sign of inferiority is not yet dead. But it has nevertheless been disappearing rapidly for some years past, and with its disappearance the development of science has kept pace. Which is the cause and which the effect it would perhaps be hard to say. At all events, the growth of every department of science has been more rapid within the last fifty years than during the preceding fifty years, though we should be doing gross injustice to our predecessors were we to belittle their work. The fact is, I am inclined to think that there never was a more fruitful period, in chemistry at least, than the last quarter of the eighteenth century. Farther on, I shall have occasion to speak of a few of the great chemical discoveries that were made during that period. No greater discoveries have been made since. In astronomy, Newton's great work was done more than two centuries ago. An age that can boast of the discovery of the law of gravitation may fairly lay claim to the title, 'the age of science.' Many and many a great discovery in science preceded the present age, but from what I have already said, you will see that the reason for calling this age in which we live the scientific age is found in the fact that scientific work is much more extensively carried on at present than at any time in the past, and, further, the world is beginning to reap the rewards of this work. So striking are some of these rewards that they appeal to all. The world is dazzled by them, and is to a large extent unable to distinguish between the scientific work which has made these rewards possible and the rewards themselves. The idea is prevalent that scientific work is carried on in order that rewards in the shape of practical results may be reached. I have no desire to bring my fellow-workers in science into disrepute. It would therefore perhaps be best for me to stop here; but, if you will bear with me, I will try to make it clear to you that one may be engaged in scientific work all his life, never thinking of what the world calls practical results, that he may in fact not achieve a single result that can be called practical, and yet not waste his time; and that one may hold such a worker up to admiration without running much risk of being taken for a fool. This will be my object in what I still have to say.

While I have thus far referred to science in the broadest sense, meaning the science of nature, let me now turn more especially to the science to which it has been my lot to devote my life, and let me endeavor to show by a few examples the relations that exist between work that appears to be of little practical value when first performed and results that, from the industrial point of view, are of the highest value.

I have often been embarrassed by these questions put to me in my laboratory: 'What are you doing?' and 'Of what use is the work?' Generally I am obliged to answer to the first, "I regret that I can not possibly explain what I am doing. I have tried to do so in some cases, but I have been begged to stop"; and to the second, the only possible answer has been, 'I do not

know.' I am well aware that such answers seem to show that the work is in fact of no value, and that this is the impression that my visitors carry away with them. Now I do not propose to try to justify my own work, nor to try to explain it. For the most part it has had to deal with matters that do not touch our daily lives, and therefore it can not be made interesting, not to say intelligible. I shall, to be sure, show you how one piece of work carried out twenty years ago has become of world-wide interest, though when it was carried out it appeared as little likely to be of practical value as anything ever done. But this is anticipating.

During the latter half of the last century there lived in Sweden a poor apothecary who, in his short life, probably did more to enlarge our knowledge of chemistry than any other man. Throughout his life he had to contend with sickness and poverty. He was obliged to carry on the business of an apothecary in order to keep the wolf from entering his house—he never succeeded in keeping it from the door. His great delight was to investigate things chemically, and to find out all he could about them. It is simply astounding to the chemist to find how many discoveries of the highest importance he made. But I have not mentioned his name. I refer to the immortal Scheele. He died in the year 1786 at the age of 43, yet he will always be remembered, and those who know most of the work he did will respect him most.

Though Scheele was an apothecary, his chemical work was not practical in the ordinary sense, and it was no doubt often difficult for him to explain what he was doing. His most important discovery was that of oxygen—a discovery that was made at the same time (1774) by the English clergyman, Priestley. Chemists know that this is one of the most important discoveries ever made in the field of chemistry, and, filled with this conviction, in 1874, one hundred years after the discovery was made, the chemists of the United States made a pilgrimage to Northumberland on the Susquehanna to do honor to the memory of Priestley, who there spent the last years of his life.

But why was this discovery so important? Oxygen, to be sure, is the most widely distributed and the most abundant substance in and on the earth; it plays a controlling part in the breathing of animals, and in most of the changes that are taking place upon the earth; a knowledge of it and of the ways in which it acts has done more than anything else to give chemists an insight into chemical action in general; and therefore has contributed more than anything else to the development of chemistry. All this is no doubt true, but are these results practical? Could we go out into the world and form a company and sell stock on the basis of such a discovery? Or could the discoverer in any way realize in cash? The average man of the world would say: "No! there is nothing in it. It may be well for a few men who have not the power to compete with their fellow-men in the busy marts to devote themselves to such useless pursuits. Possibly something may come of it in time, but better something practical, something that can be converted into hard cash. That is the test, and the only fair test by which we can judge whether any particular piece of scientific work is or is not of value."

But I have already said that the discovery of oxygen was the most important discovery ever made in chemistry, and I might have added, the most valuable. In what, then, did its value consist? In the fact that it led to a more intelligent working with all things chemical. Operations that had before this discovery appeared mysterious suddenly became clear, and every one engaged in chemical work was helped

in many ways. If it is not enough for us simply to gain a clearer insight into the processes around us, if we must insist upon more tangible reward, no doubt it could be shown that the discovery of oxygen has contributed largely to the material welfare of mankind—not directly perhaps, but by enlarging our knowledge of chemistry, so that it may be said that most discoveries made since 1774 have been in a way consequences of the discovery of oxygen. Indirect results are often of more value than direct ones.

But there is another discovery of Scheele's that illustrates in another way that a discovery that when made appears of little or no practical value, may eventually prove of immense practical value and become the basis of a great industry. This is the discovery of chlorine. Among the many substances examined by Scheele was one that is commonly known as black oxide of manganese. This occurs in nature in large quantity and has long been of interest to chemists. Scheele treated this with about everything he could lay his hands on, as was his way. When muriatic acid, or, as it was called by the older chemists, the spirit of salt, was poured on the black oxide of manganese, he noticed that something unusual took place. He soon became aware that a colored gas was given off, and that this gas had other properties besides that of color. It affected his eyes, nose, throat and lungs in most disagreeable ways. Many of those before me have had the experience of inhaling a little of this gas. I hope no one has inhaled much of it. It is one of the most disagreeable things chemists and students of chemistry have to deal with. And it is not only disagreeable, it is extremely poisonous. But Scheele did not stop his work because it involved discomfort and even danger. He persisted and carried it to a successful issue, and when he stopped he was able to give as satisfactory an account of the now familiar chlorine as we can give to-day. The investigation is a model. It could not have been accomplished without the enthusiasm, the patience, the knowledge and the skill possessed by Scheele. No ordinary chemist would have been equal to it. We shall not overstate the case if we say that Scheele's discovery of chlorine ranks with the most important and the most valuable of chemical discoveries. That of oxygen outranks it certainly, but chlorine falls in line not far behind.

Now, why was this an important and a valuable discovery? Primarily because it, like the discovery of oxygen, though to a less degree, aided chemists in their efforts to understand chemistry and thus to put them in a position to deal more intelligently with chemical problems of all kinds. That statement may, once for all, be made of every important chemical discovery. But while Scheele had no thought of any practical uses to which chlorine could be put, and his discovery was not at first regarded as one with a practical bearing, it proved eventually to be of the highest practical value, and to-day it plays an exceedingly important part in practical affairs. As is well known, chlorine is the great bleacher, and as such is used in enormous quantity, especially for bleaching straw, paper and different kinds of cloth. As it would be expensive and inconvenient to transport a gas, and especially such a gas as chlorine, it is locked up, as it were, by causing it to act upon lime, and the 'chloride of lime' or 'bleaching powder' thus formed, which readily gives up its chlorine, is a most important article of commerce, many thousands of tons being manufactured annually. Then again chlorine is one of the most efficient disinfectants, and as such it is finding more and more extensive use every year, and is plainly contributing to the welfare of man by interfering with the spread of

disease. Further, it is essential to the manufacture of chloroform, and that this calls for a large quantity of chlorine will appear when it is stated that nearly nine tenths of the weight of chloroform is chlorine. Chloroform, which has been of such inestimable value as an alleviator of pain, can not be manufactured without chlorine, and it could never have been discovered without the previous discovery of chlorine.

Finally, without attempting to give a full account of all the uses to which chlorine has been and is put for our benefit, let me mention one more application, though in doing so I may run the risk of leading some of you to the conclusion that chlorine has its dark side as well as its light. It is with some misgivings that I venture to tell you that chlorine has found extensive application in the extraction of gold from its ores, and as gold is held by some to be the root of all evil, chlorine must, by the same token, be regarded as *particeps criminis*. A few years ago I visited the gold mines in the Black Hills of South Dakota, and there I spent some time in examining the chlorination process. I could not help thinking of Scheele and his simple experiments that first brought chlorine to light. I wondered whether, if he could see the extensive applications of that greenish-yellow gas that first set him to weeping and coughing—I wondered whether his satisfaction in his work would be any greater than it must have been when the discovery was made. Compare the little room in the apothecary shop, the simple apparatus, and the apparent uselessness of the noxious gas with the great factories, the complicated machinery and the valuable applications already mentioned, and it is evident that a discovery that appears least promising from the practical point of view may be the beginning of the most valuable industries.

Before leaving this part of my subject let me take a much less important example than those already spoken of, but one that comes nearer home. Nearly twenty-five years ago in the laboratory under my charge, an investigation was being carried on that seemed as little likely to lead to practical results as any that could well be imagined. It would be quite out of the question to explain what we were trying to do. Any practical man would unhesitatingly have condemned the work as being utterly useless, and I may add that some did condemn it. There was no hope, no thought entertained by us that anything practical would come of it. But lo! one day it appeared that one of the substances discovered in the course of the investigation is the sweetest thing on earth; and then it was shown that it can be taken into the system without injury; and finally, that it can be manufactured at such a price as to furnish sweetness at a cheaper rate than it is furnished by the sugar cane or the beet. And soon a great demand for it was created, and to-day it is manufactured in surprising quantities and used extensively in all corners of the globe. Thousands have found employment in the factories in which it is now made, and it appears that in some European countries the new substance has become the sweetening agent of the poor, it being sold in solution by the drop.

It is unnecessary here to discuss the question naturally suggested by the facts just spoken of, whether the discovery of the sweet substance has benefited the human race. It would be extremely difficult, if not impossible, to answer this question. But whatever the answer, it is clear from what has been said that the discovery was of importance from the practical point of view, and there was nothing originally in the work to suggest the possibility of a practical result in the sense in which the word practical is commonly employed.

This is the lesson that we learn over and over again as we study the great industries.

Rarely have they been the results of work undertaken with the object of attaining the practical. Look at the beginnings of electricity. A piece of amber when rubbed attracts bits of pith. A frog's leg twitches after death when touched in certain ways with metals. That was all. Are such things worth investigating? No doubt the practical man said: 'No; stop trifling: do something worth doing.' And if he had been permitted to have his way, all the wonderful results that depend upon the applications of electricity would have been impossible. In every line, much study, much work, and much investigation are absolutely necessary before enough knowledge can be got together to make profitable, practical applications possible. During this early preparatory stage the work is of no direct interest to the purely practical man; and yet without this work the applications which he values would be impossible. Scientific work in its highest form does not pay directly. Those who devote themselves to the pursuit of pure science do not, as a rule, reap pecuniary reward. They probably enjoy their lives as much as if they did, though it is often difficult to make them believe this. But because it does not yield immediate reward to the worker, should the work stop? Surely not. Our only hope of progress in intellectual as well as practical matters lies in a continuation of this work. And even though not a single tangible, practical result should be reached, the work would be valuable. Why? Because we are all helped by knowledge. The more we know of the universe the better fitted we are to fill our places in the world. All will concede the truth of that proposition. But if this is true we have the strongest argument for scientific work, for it is only through such work that we are enlarging our knowledge. There is no other way of learning. Somebody must be adding to our stock of knowledge, or what we call progress in intellectual and material things would stop. It also seems probable that moral progress is aided by intellectual progress, though it might be difficult to make this perfectly clear. I believe it is so; though of course it does not follow that every individual furnishes evidence of the relation between intellectual and moral progress.

But, my friends, whether we will or not, scientific investigation will go on as it has been going on from the earliest times, and it will go on more and more rapidly with time. The universe is inexhaustible, and its mysteries are inexplicable. We may and must strive to learn all we can, but we can not hope to learn all. We are finite; the mysteries we are dealing with are infinite.

IRA REMSEN.

HIGHER EDUCATION IN GERMANY AND THE UNITED STATES.

AN article on 'Thirty Years' Growth of German Universities,' which recently appeared in one of the educational magazines, suggests an investigation along similar lines with reference to our own country and a comparison of existing conditions. There can be no doubt of the fact that there is manifested in this country an increasing purpose to lead the intellectual or the scientific life, which will inevitably tend to raise the standard of American civilization and culture. The growth of our leading universities within the past decade bears eloquent testimony to this fact, and we have no reason to be dissatisfied with the progress that has been made in the field of higher education. A mere glance at the figures in the above-mentioned article describing the growth of the higher institutions of learning in Germany will convey a good idea of the marvelous intellectual advancement of the nation since the Franco-German war. The author shows that, while there had been an increase of 38.9 per cent.

in the male population of Germany between 1870 and 1900, the number of students in attendance at the universities and schools of technology, mining, forestry, agriculture and veterinary science has grown no less than 163.8 per cent., and allowing graduates of these institutions also to enter into his calculations, he finds that in Germany the number of men of university training has doubled within the last thirty years. The total number of university students for 1900 is given as 46,520 and the number of males in the population of the country as 27,731,000, there being thus 16.78 students for every 10,000 males, as against 8.83 thirty years ago.

In attempting to compare the educational conditions represented by these figures with those of the United States, several obstacles are encountered at the very outset. In the first place, American statistics would not be complete and would not constitute a fair criterion of the educational characteristics of our country, were we to exclude from them all women students, for aside from the large enrollment at colleges for women and the great body of women pursuing graduate or professional courses at the universities, it is not at all unusual to find the women in the collegiate departments of our larger universities, especially the state institutions, far outnumbering the men. It is scarcely necessary to state that in contradistinction to this state of affairs, the policy of permitting women to study at the German universities is just beginning to be looked upon here and there with any degree of favor. It would hardly be appropriate to deny woman a place in the intellectual activities of our nation, and we shall, therefore, arrive at a fairer basis of comparison if we take into consideration not only the number of male inhabitants, but the total population of the country. Adopting this basis, we find that in Germany's population of over 56,000,000 there were in 1900 about eight students for every 10,000 inhabitants.

In the second place, it would be manifestly unjust to Germany were we to draw conclusions in regard to the relative participation of the people in higher education in this country and in Germany without first making deductions for the further dissimilarities of conditions that confront us at every turn. The term higher education, as employed in the United States, is a more comprehensive one than it is in Germany, including as it does with us a large number of college students and students in the academic departments of universities who would not be regarded in Germany as university students. Moreover, in Germany every professional student is in reality a graduate student; no one is permitted to matriculate in the faculty of law, medicine, or theology without possessing the *testimonium maturitatis*, the equivalent—in general terms—of our baccalaureate degree, whereas we can boast of only a few institutions that call for a first degree as a prerequisite for admission to any one of these faculties, notably Harvard University for law, medicine and theology, Columbia University for law, and Johns Hopkins University for medicine. It seems reasonable to suppose that at least the more prominent American universities will adopt the higher admission requirements for the professional faculties within the next decade. At all events, even the most strenuous opponents of the theory must admit that the recent growth of the Harvard law school, which can point with pride to an enrollment of over 700 students, is a splendid justification of the lately adopted ideal condition.

Turning from the American professional schools with their inferior requirements to the so-called graduate or post-graduate faculties, we meet with conditions that are

most encouraging, for the number of graduate students in our universities has more than doubled within the past five years. Columbia University alone has almost 700 resident candidates for the higher degrees registered under its graduate faculties of political science, philosophy and pure science, the majority of whom are preparing themselves for the teaching profession. And here we have another encouraging feature of the educational development of our country, viz., the improved facilities for intellectual growth offered to our teachers by means of summer schools, extension courses, public lectures, and similar enterprises conducted under the auspices of our leading universities. At its summer session of 1903 Harvard enrolled almost 1,400 students, and almost 700 students are at present pursuing resident work at the Teachers College of Columbia University, which this year is also giving extension courses to 1,600 students.

Having called attention to the difficulty of making direct comparisons of the growth of higher education in Germany and the United States, let us at least examine some of the salient features of this growth in both countries. Viewed from the standpoint of increase of proportion of students to the entire population, the comparison slightly favors the United States, although the difference is not great, and the advantage would be lost entirely were we to make due allowance for the differences in conceptions discussed above. The following figures will serve to illustrate this point: In 1870 the United States had a population of 38,000,000, which by 1900 had increased to 76,000,000, *i. e.*, it had virtually doubled. In 1872 there were 8.52 students of both sexes in all branches of higher education to each 10,000 inhabitants, whereas in 1900 there were 19.13, somewhat more than twice as many. In Germany the increase between 1870 and 1900 was a little less than double, from 8.83 to 16.78 students for every 10,000 males, the total population of the country having increased from 41,000,000 in 1871 to 56,000,000 in 1900. We must also take into consideration the fact that the United States is growing much more rapidly than the German Empire. In the last decade of the nineteenth century the population of Germany increased 14 per cent., while that of the United States increased almost 21 per cent., and this great increase in the population of our own country is comprised largely of immigrants, of whom only a relatively small proportion is interested in higher education. Another interesting fact is brought out by comparing the actual numerical growth of the student body of the two countries, and employing this basis, the comparison would again favor the United States. Between 1889 and 1900 the total number of students in attendance at the German universities increased 36 per cent., whereas in America between 1890 and 1901 the total increase in the number of undergraduate and resident graduate students in universities, colleges and schools of technology amounted to 86 per cent., and there would be little change in the relative growth were the comparison extended to cover the past thirty years.

One of the most interesting points adduced in the article mentioned is the marked change in the distribution of the students among the different classes of institutions, the figures demonstrating that the schools of technology have since 1892 expanded uninterruptedly and much more rapidly than the general universities. The reason for this expansion is to be sought not so much in the existence of lower entrance requirements for the schools of technology, nor in the circumstance that several schools have been permitted to confer an engineering degree, although both of these factors have some bearing on the development in question. We must go

further to find the true cause. During the past decade Germany has made tremendous advances in the field of industries and manufactures, just as has the United States, and the main reason for the increase in the number of students of technology in both countries—the multiplication of this class of students in our own country during the past decade has been quite marked—is found in the endeavor to supply a demand, the prospective student carefully weighing the chances of earning a livelihood in one field or another. Wherever the supply begins to exceed the demand, a tendency toward reduction is immediately felt, as witness the falling off in the number of medical students in this country and elsewhere during the past year, which in spite of increased standards of admission and other minor causes, must be attributed in the main to the existing superabundance of physicians. In other words, at the present day when the professional schools are making such headway at the expense of the old general culture course, university attendance becomes more and more influenced by existing economic and industrial conditions, especially in a country like the United States, in which the practical side of life is emphasized with such vigor, and likewise in a country such as Germany, which during the past few years has adopted so many of our own methods in the conduct of its industrial and commercial affairs. While Germany can not be said to have sacrificed any educational ideals for this new movement, it has at all events allowed the influence of things practical to be strongly felt. In connection with this important question of the widespread increase of applied science students as affecting both Germany and the United States, we might point out that in no instance does a German school of technology form a coherent part of a university proper, as is so frequently the case in this country. And what is more, it seldom happens that a German technological school is located in a university town, and more than one such school is never, under any circumstance, allowed to exist in the same city, whereas in the United States we revel in the luxury of supporting several technological departments within hailing distance of one another, to mention only Harvard University, the Massachusetts Institute of Technology and Tufts College, for Boston, and Columbia University, the Stevens Institute of Technology and New York University, for New York City, all of which institutions offer courses in applied science.

Nothing furnishes a more vivid illustration of the practical tendencies visible in American education than the existence of departments of commerce and accounts as constituent parts of several of our leading institutions of learning, and the contemplated establishment of a school of journalism in connection with Columbia University is but another phase of this constant and growing endeavor to enlarge the field of legitimate university activity in practical directions.

Summarizing briefly, we have found that both in Germany and in the United States wonderful progress has been made in recent years in the spread of higher education, and this development may be regarded as a specific manifestation of the general material prosperity which has characterized the life of both countries during the past thirty years. The amazing development of the industrial activities of both nations has found a decided reflection in the rapid increase in the enrollments of the schools of technology and the university faculties of applied science, an increase far above the normal and illustrative of the modern striving to bring education into closer and closer accord with the living issues and problems of the day. And no harm will result from this tendency, pro-

vided the proper ideals are never sacrificed to the popular demand, for there seems to be no cogent reason why the intellectual advancement of a nation should not be in perfect harmony with all those things that constitute the sphere of its practical activity. The future of higher education in Germany and in the United States will be proof against all attacks, provided there is no diminution in the proportion of persons animated by a desire to lead the intellectual life, and provided further that we never cease to adhere to those ideals of scholarship and learning which have contributed in such bountiful measure to Germany's commanding position in the educational world.

RUDOLF TOMBO, JR., PH.D.,
Registrar, Columbia University.

SCIENTIFIC BOOKS.

Catalogue of the Ward-Coonley Collection of Meteorites. By HENRY A. WARD, A.M., LL.D. Pp. xii + 113, with 10 plates. Published by the Author. Chicago, May, 1904.

The Ward-Coonley collection of meteorites comprises at the present time representatives of more falls than any other collection in the world. Of about 680 meteorites known, the Ward-Coonley collection contains 603, which is 43 more than the number in the Vienna collection, according to the latest catalogue (1902), and 46 more than the British Museum collection contains, according to its latest catalogue (1904). The attainment of so remarkable a completeness by the Ward-Coonley collection is set forth in the catalogue just published by Professor Ward. The work contains much information of value besides being a catalogue.

In an interesting preface the author describes the manner in which the collection has been built up. Attention is called to the fact that exchange has proved quite as important a means of acquiring meteorites as purchase, and a liberal policy in this regard on the part of museums and collectors who would enlarge their collections is urged. The Gregory and Siemaschko collections are stated to be largely incorporated in the Ward-Coonley collection, while extensive travel by Professor Ward yielded meteorites obtainable in no other way. The first seventy pages of the catalogue are devoted to a list of the meteorites represented in the collection. These are arranged alphabetically under the groups of siderites, siderolites and aerolites. The list gives the name of the meteorite preferred by the author, its classification according to Brezina's system, the latitude and longitude of the locality and a statement of the locality according to political divisions. Reference to the first description of the meteorite is then given and the weight in grams of the chief piece and total weight in the Ward-Coonley collection. It is evident that great care has been taken to render this part of the catalogue accurate in detail, and the large amount of painstaking labor necessary to achieve this result can be appreciated only by those who have essayed similar tasks. So thoroughly has the work been done, however, that this catalogue may be considered the most authoritative work now extant in regard to the names and localities of the meteorites which it lists. American locality names of meteorites in particular have suffered so wofully from the mistakes of foreign authorities hitherto that it is cause for congratulation that the matter has been taken in hand by one so familiar with the subject as Professor Ward.

Following the list of specimens in the Ward-Coonley collection, an alphabetical list of all known meteorites is given with such synonyms as have importance. Here again the wide experience and knowledge of the author give the list a peculiar value. It has not been burdened with synonyms resulting from imperfect or careless spelling, but genuine synonyms have been retained.

The next division of the catalogue shows the geographical distribution of all known meteorites according to countries. The meteorites of each country are arranged alphabetically under that division and their date of fall or find, and classification as iron or stone shown. Division VI. of the catalogue has been contributed by Dr. Brezina, of Vienna.

This gives in complete form the classification of meteorites wrought out by Dr. Brezina at the Vienna Museum and now brought quite up to date. Seventy-four groups are named and under each group are given the meteorites assigned to each. The complete presentation of this classification is a work which will be of great service to students of meteorites and an aid to further study of the groups. Following this a table shows to what extent these groups are represented in the Ward-Coonley collection. It appears that all the groups are represented and 95 per cent. of the group localities. The total weight of the collection is given as 2,495 kilos (5,509 pounds), and the total number of specimens as about 1,600. The average weight of the representatives of each fall is 4,138 grams ($9\frac{1}{9}$ pounds), or, counting nothing over 50 kilograms to a fall, 1,746 grams ($3\frac{4}{5}$ pounds).

The following meteorites are stated to have larger representatives in the Ward-Coonley collection than in any other: Among siderites, Arispe, Bacubirito, Ballinoo, Cañon Diablo, Canyon City, Central Missouri, Costilla Peak, Illinois Gulch, Luis Lopez, Nejed, Roebourne, Saint Genevieve, Surprise Springs, Tonganoxie, Ute Pass and Willamette. Among siderolites, Morristown, Pavlodar and Veramin. Among aerolites, Baratta, Bluff, Castine, Indarch, MacKinney, Mighei, Ness County, Oakley, Petersburg, Pipe Creek and Rushville.

Adjuncts to the collection such as casts, micro-sections, betyl coins, etc., are listed and the ten illustrative full-page plates show the appearance of about fifty typical specimens of the collection and the manner of mounting and installation.

It is a cause for felicitation that so large and complete a collection of meteorites is to be found on this side of the Atlantic, and students of science will join with Dr. Brezina in congratulating, as he does in a recent letter which the present writer has been permitted to see, Professor Ward 'upon the results of such uncommon energy and experience. Instead of three first-class world collections, Vienna, London and Paris,' says Dr. Brezina, 'there exist now four.'

Oliver C. Farrington.

Le Mouvement. By R. S. Woodworth. Paris, O. Doin. 1903. Pp. viii + 421. 4 fr.

This volume, which is a part of the 'Bibliothèque internationale de psychologie expérimentale normale et pathologique,' edited by Dr. Toulouse, is an excellent and complete discussion of movement in all its aspects.

The work is divided into two parts, viz., I., on the perception of bodily movements, and II., on the production of movement.

In the first part there are excellent accounts of the physiological, clinical and anatomical findings regarding the muscular sense, and of the functions of the semi-circular canals in relation to sensations of movement. The remainder of the section is concerned with a general survey of the literature on the perception of the extent, the time, and the force of movement, on the perception of lifted weights, on weight illusions, and a critique of Weber's law in relation to the perception of movement.

The second part—on the production of movement—consists in discussions regarding reflex action, coordination, dynamogenesis, motor automatism, voluntary movement, rapidity of voluntary movement—including reaction time—the precision of movement, and fatigue.

Not every one will agree with the author regarding the rôle of the synapses in the production of habits, etc. (p. 227): "S'il y a un arrêt quelconque dans le système nerveux, comme cela arrive pendant le sommeil, il provient probablement du synapse. Et probablement aussi, c'est le dévelopement des extrémités nerveuses et le rapprochement des extrémités des branches de dendrites et de l'axe qui produisent la formation des habitudes et la maturité des instincts." The movements of dendrites and the shortening of spaces between parts of contiguous neurons has not been sufficiently investigated to make the above statement 'probable.'

Fatigue is considered to be a phenomenon connected with muscle, very little or not at all with the neurons controlling the muscle. This view, it is admitted, is somewhat radical, but the author guardedly concludes that 'the theory of the participation of the central nervous system in motor fatigue is without proof' (p. 400). It might also be retorted

that the theory of muscle being the only seat of so-called motor fatigue is yet without proof. The early experiments of Mosso and of other investigators do not clearly establish a nervous fatigue, but results in these, and certain later experiments may be explained in either way, namely, that there is nervous fatigue or that there is only muscular fatigue. There is, indeed, as much reason to say that there is a widening of the synapses in fatigue as in sleep (see above).

Such a book has long been needed both by psychologists and by physiologists. Material has been carefully chosen from psychological, physiological and clinical literature, and theory has been properly subordinated to fact.

SHEPHERD IVORY FRANZ.

MCLEAN HOSPITAL,
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SOCIETIES AND ACADEMIES.

SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE seventh regular meeting of the society was held on Wednesday, May 18, at 8:30 P.M., in the physiological laboratory of the New York University and Bellevue Hospital Medical College at 338 East 26th Street. Dr. S. J. Meltzer presided.

Members present.—Adler, Burton-Opitz, Dunham, Ewing, Gies, Jackson, Levene, Lusk, Meltzer, Murlin, Richards, Salant, Wadsworth, Wallace, Yatsu.

Members elected.—P. B. Hawk, W. G. MacCallum, A. R. Mandel, R. M. Pearce, Franz Pfaff, William Salant, H. U. Williams, A. S. Warthin.

ABSTRACT OF REPORTS ON ORIGINAL INVESTIGATIONS.*

The Lecithin Content of Fatty Extracts from the Kidney (*Preliminary Report*): E. K. DUNHAM.

Rosenfeld has shown that the percentage of the alcohol-chloroform extracts from the dried kidneys of dogs, both normal and 'fatty,' fluctuates within very narrow limits. He calls these extracts 'fat,' and regards the microscopical examination as entirely untrustworthy for gauging the amount of fat in the kidney. His work on other organs has led him to the conclusion that, when the fat content is increased in the cells, it has been transported from the fat-depots of the body. It appeared to the author of interest to compare the extracts obtained from the kidney by Rosenfeld's method with similar extracts from the depot-fats. It was at once evident that they differed markedly in the percentage of phosphorus they contained, as is shown by the following analytic results.

Alcohol-chloroform Extracts.	Percentage of Phosphorus.
Human kidney (mean of 28 analyses)	1.3849
Panniculus adiposus (4 2288 grams)	0.0026
Perinephritic fat (5.6750 grams)	0.0069

The extract from the kidney contains from 200 to 500 times as much phosphorus as the extract from depot-fat. These facts suffice to show that the two extracts are not directly comparable, and to throw doubt upon the idea advanced by Rosenfeld that the fat in 'fatty' organs is a simple infiltration from the depots of the body.

The phosphorus in these extracts was found to be wholly organic in character. Protagon could not be detected even in 400 grams of the tissue. The quantity of jecorin that may have been present was too small to influence materially the analytical results. The most probable compounds containing the phosphorus are forms of lecithin. The barium hydroxide-platinic chloride method for the separation of cholin was employed with the following results:

	Extract, Grams.	Phosphorus, per cent.	Platinum, Gram.	Licithin in the Extract (Calculated as Di-stearyl-lecithin), per cent.
I.	0.4600	1.43	—	37.23
	0.4600	1.47	—	37.45
	1.5859	—	0.0650	34.50
II.	0.6032	1.12	—	29.11
	0.6032	1.11	—	28.99
	2.1556	—	0.0711	27.40

Before incineration, in the first case, the platinum salt in the crucible weighed 0.2009

* The authors of the reports have furnished the abstracts. The secretary has made only a few abbreviations and minor alterations in them.

gram. The platinum, therefore, constituted 32.7 per cent. of the salt. Cholin platinic chloride contains 31.6 per cent. of platinum. It appears highly probable, however, that some of the platinum salt was decomposed during the concentration of its solution with heat. It is also possible that some of the cholin suffered decomposition, or was lost, in the manipulations preceding its precipitation with platinic chloride. With these considerations in mind, the foregoing results render it highly probable that the phosphorus is present in some form of licithin, but although these calculations are based on di-stearyl-lecithin, it is certain that this is not the only lecithin present. The fact that lecithin obtained in moderate purity (about 99 per cent.) from the kidney extract promptly blackens with osmic acid, indicates that the oleic acid radicle is present. The recognition of this fact would make but trifling changes in the calculations in this report.

The foregoing analyses appear to justify the conclusion that one may, at least tentatively, assume the phosphorus content of the extracts obtained to be dependent upon the presence of some form of lecithin.

Upon this assumption the calculations given in the following table* are based:

	Extract, % of Dry Organ.	Phosphorus, % of the Extract.	Lecithin. % of the Extract.	Lecithin, % of Dry Organ.	Autopsy Report. Cause of Death.	Autopsy Report. Weight of Kidney.
			Human Kidneys.			Grams.
I.	11.42	2.11	55.07	6.29	Pneumonia and hepatic abscesses.	200
	12.48	2.00	52.03	6.49		
II.	11.44	1.35	35.14	4.02	Tuberculosis.	200
XI.	15.40	1.18	30.84	4.76	Moderately fatty kidneys.	——
	15.51	1.19	31.09	4.80		
			Beef Kidneys.			
II.	15.02	2.10	54.64	8.21	——	——
			Dog Kidneys.			
I.	14.93	2.04	53.29	7.95	——	——
			Rabbit Kidneys.			
I.	16.59	2.53	66.06	10.96 †	——	——

* The author presented a large number of data. The table here given shows only a few examples of the many results obtained.

† 2.24 per cent. of the fresh kidney.

These analyses demonstrate that even in the kidney, which can not be regarded as one of the fat-depots of the body and which probably plays little, if any, part in the general fat metabolism, the lecithin content must be taken into consideration in any study of the fatty extract. The limited number of the observations here referred to do not justify conclusions bearing upon the question of the nature of the fatty changes met with in the kidney, but it is the author's intention to continue the study of this subject.

On the Phloridzin Test in Bright's Disease: P. A. Levene and L. B. Stookey.

Investigation of the action of phloridzin in Bright's disease has a theoretical as well as a practical interest. The mechanism of kidney diabetes is as yet imperfectly understood. The original idea that it was due to a change in the permeability of the kidney epithelium has gradually lost support, and instead there is a growing belief in the hypothesis that, in kidney diabetes, the sugar owes its origin to an exaggerated catabolic condition of the kidney. This view was first expressed by one of the authors in 1894. In support of this theory evidence was brought forward to show that in animals with injured kidneys, phloridzin fails to bring about glycosuria, or causes it in less degree than in normal animals. However, it is impossible to injure, by means of drugs or by mechanical interference, only one special part of the kidney. In the course of Bright's disease there are known conditions under which the involvement of either the epithelium or of the glomeruli predominates to a very great extent, and this, of course, enables one to study the seat of the sugar formation within the kidney. The observations of most authors tend to show that when the epithelium of the kidney is injured administration of phloridzin fails to cause glycosuria or does so in very slight degree.

The authors injected simultaneously phloridzin and methylene blue, and compared the course of the elimination of the dye with that of the sugar. The results of their observations in a general way corroborate the statements made by other writers. In acute parenchymatous Bright's disease sugar fails to

appear in the urine after the administration of phloridzin. In chronic forms of the disease, when only a trace of albumen can be detected in the urine, and when the permeability of the kidney for methylene blue is normal, there is frequently a diminished sugar elimination—diminished as compared with that in health under the influence of phloridzin. In no case was there observed an impaired permeability for methylene blue with a normal sugar elimination, but the contrary was often the case.

Levene's modification of Allihus's method was used for the sugar determinations. Further work in this direction is in progress.

Effect of Blood Serum in Pneumonia upon the Heart (Preliminary Report): ISAAC ADLER and RICHARD WEIL.

The object of these experiments was to determine whether blood serum in pneumonia has a specific effect upon the heart and, also, whether there is any difference in action between the serum taken *before* and the serum obtained *after* the crisis. The experiments were made upon the heart of the turtle, use of the mammalian heart being impracticable, in this connection, for many reasons. The fluids to be tested entered the heart through a glass cannula introduced through the right aorta into the corresponding ventricle, passed through the septum into the left ventricle and flowed out through a cannula in the left aorta. Care was taken to keep the temperature, concentration and hydrostatic pressure uniformly constant. The veins were all carefully ligated. The small diaphragmatic vein at the apex was tied and cut, the ligature connected with a writing lever, and the contractions of the heart thus recorded upon a drum.

Normal human serum acts upon the heart of the turtle as a violent inhibitor, but it was found that in a dilution of 1–20, or better still, 1–15, it does not differ greatly in effect from 'normal saline.' All sera were thereupon tested in dilution of 1–20 or 1–15, and the routine of each experiment as ultimately adopted was as follows: Infusion into the heart, (*a*) 'normal saline,' (*b*) normal blood serum, (*c*) 'normal saline,' (*d*) serum *before* crisis, (*e*) 'normal saline,' (*f*) serum *after* crisis. In this manner after considerable preliminary experimentation very characteristic tracings were obtained.

Two cases of lobar pneumonia and one case of broncho pneumonia have thus far been studied. The tracings obtained were demonstrated and it appeared from them that the serum in pneumonia before the crisis, at least in the cases tested, acted upon the heart of the turtle as a most violent poison. The contractions at once became extremely weak and slow and the pauses very long. The serum taken after the crisis gave tracings not very materially different from those obtained with normal serum.

The Influence of Alcohol on Biliary Secretion: WILLIAM SALANT.

In the author's experiments, fasting or well fed dogs were the subjects. Operation and collection were conducted in the usual manner. Ether narcosis was employed in every instance without previous injection of morphine. The rate of secretion was studied by comparing the amounts collected during periods of fifteen minutes. The rate of secretion during the first four or five periods was used as a control, at the end of which time alcohol was injected by means of a burette into the femoral vein. Varying strengths of alcohol were used, four and one half per cent., thirty per cent. and sixty per cent. The quantities administered were usually about 4 c.c. per kilo of body weight.

After the injection of alcohol it was found in all cases that the secretion of bile continued to diminish, the diminution in the rate of secretion being, however, somewhat greater than in the two or three control periods immediately preceding the administration of alcohol. Since the much larger quantity of bile of the first and second periods probably represents bile that has been held back during the operation, it could not be considered as a control. The author, therefore, regarded as a control the rate of secretion during the following two or three periods. Whether this slightly diminished secretion is to be ascribed to the influence of alcohol can only be decided by further comparisons of the rate of secretion in alcoholized and normal animals. Thus, in

three dogs without alcohol the rate of secretion corresponding to the alcohol periods was as follows: A decline during the fourth, fifth and sixth periods, succeeded by a rise in the next period. In the second experiment the rate of secretion remained practically steady during the fifth, sixth, seventh and eighth periods. In the third experiment there was a variation, but the average rate of secretion was about the same in the fifth, sixth and seventh periods as in the preceding two experiments. It would seem, therefore, that the diminished secretion following intravenous injection of alcohol might be due to the effect of alcohol.

A study of the effect of alcohol on biliary secretion after injection into the stomach was also begun. It would seem *a priori,* in the light of recent investigations by Bayliss and Starling, Fleig and Henriot, on the relation of secretin to the secretion of bile, that the author's method of administering alcohol ought to provoke secretion of bile. In the few experiments the author has made thus far he has observed that when sixty per cent. alcohol was introduced into the stomach there was a slight, transitory increase of biliary secretion. With thirty per cent. alcohol there was in some cases an increase, in some a decrease, of the secretion of bile as compared with prealcoholic periods. At this stage of the work it would be premature to form any conclusion regarding this point. Whether this slight increase is due to increased gastric secretion and consequent formation of secretin, or is reflex in nature, will next be investigated.

The Influence of Repeated External Hemorrhages on the General Composition of the Blood. G. M. MEYER and W. J. GIES.

Various observers have noted the fact that the composition of the blood changes after hemorrhage, but no systematic study has been made of these modifications. The authors have begun such an investigation for the purpose of establishing a more definite basis for comparative blood analysis. They reported the results of their observations on posthemorrhagic changes in the percentage content of water, total solids, organic solids and ash. Further study is in progress.

Healthy, well nourished or fasting dogs, in light morphia-atropin narcosis were used and quantities of blood ranging from 0.2 to 1.0 per cent. of body weight were taken. These amounts were drawn from the femoral artery and approximately the same quantity was taken in each experiment at regular intervals, varying from fifteen minutes to two hours, until death ensued. In one experiment a continuous fatal hemorrhage was effected and the blood analyzed in portions. Thus far twenty experiments have been carried out. In some of them the serum was also analyzed.

The following conclusions were reported: Hemorrhage causes increase of water and decrease of solids in the remaining blood. *Hemorrhages of about 0.6 per cent. of body weight* cause little or no change in general composition of the blood until after 2.5 per cent. has been taken. Under the conditions of these experiments it was generally found that the longer the intervals between withdrawals the less the maximal differences between composition of the first and last fractions. Short intervals between bleedings, all other conditions being equal, favored the largest total withdrawals before death ensued.

The differences in the serum ran parallel with those in the blood, but were less marked. The ash did not vary very much in either the blood or the serum, no matter how much blood was taken. The blood ash and that from the serum were practically the same in relative amount, though different in composition.

When *small* quantities of blood *equal to about 0.2 per cent. of body weight* were removed at intervals of about a half-hour, little change was noted in either blood or serum until after 3 per cent. had been taken. After this quantity had been lost the changes following further hemorrhage were such as usually occur. The maximum differences in percentage composition of the first and last fractions varied somewhat. The differences in the amounts of solids, for example, ranged from 1.5 to 3.5 per cent.

In *fasting animals* the influence of hemorrhage on chemical change in the remaining blood was somewhat more marked than in well

nourished ones. The effect on the serum was about the same.

Other influences in the experiments were carefully controlled. The observed effects were due only in slight degree to the narcotics and the conditions attending the operations.

Demonstration of a New Portable Sphygmomanometer: T. C. Janeway.

Dr. Janeway's instrument was designed with the object of securing a thoroughly portable clinical sphygmomanometer, in which nothing essential to accuracy should be sacrificed. It employs the method of circular compression of Riva-Rocci, and Hill, with the 12cm. width of armlet proved necessary by Von Recklinghausen. The special construction of the cuff allows of adaptation to arms from 15 to 34 cm. in circumference. The original feature of the instrument is the folding U-tube manometer. This is a jointed U-tube manometer (copied from Cook), fastened to the under surface of the box-lid, so arranged that, when closed for carrying, it measures $10\frac{1}{4} \times 4\frac{5}{8} \times 1\frac{7}{8}$ inches, and with armlet and inflator weighs $2\frac{1}{2}$ pounds. The manometer is perfectly secure when closed and stands firmly when open. The tube-caliber is 3 mm. The sliding scale is empirically graduated for each instrument, to compensate for variation in the glass tubing, and is accurate. All connections are of heavy pressure tubing. For inflation a Politzer bag is used, as by Erlanger, except that one with valve is necessary to fill the large armlet. The gradual release of pressure is provided for by a stop-cock, with needle-valve of special construction, the work of Mr. Charles E. Dressler, who is making the sphygmomanometer for sale.

The method of use, as of the other modern sphygmomanometers, is based on the criterion of the return of the pulse after obliteration (Vierordt), for systolic pressure, and is similar to the Riva-Rocci and its modifications. A fair approximation of diastolic pressure may also be obtained in most cases, using the criterion of maximum pulsation (Marey, Mosso). This is especially useful in cases of aortic insufficiency, or marked hypertension. For experimental work upon the systolic and diastolic pressures, it can not compare with Erlanger's more elaborate and costly instrument, but aims to serve the clinician by providing him with an accurate yet not bulky or costly instrument, for general use. Stanton's sphygmomanometer, which appeared after this one had been begun, answers the same purposes. The only criticism to be made of it is, that 8 cm. width of armpiece does not afford a guarantee of complete accuracy on large arms.

Demonstration of Cytological Preparations: Naohidé Yatsu.

Mr. Yatsu exhibited seven preparations demonstrating important cytological structures found both in eggs normally fertilized and in some treated chemically. He spoke on the achromatic figure in mitosis, with special reference to the morphology and cycle of the centrosome.

Preparation I. Metaphase of the first polar mitosis with two centrioles at each pole (egg of *Cerebratulus*).

Preparation II. Sperm nucleus with sperm aster, in which each daughter centriole has acquired a new system of rays (egg of *Cerebratulus*).

Preparation III. Anaphase of the first cleavage mitosis, showing two centrioles in each centrosome (egg of *Cerebratulus*).

Preparation IV. Telophase of the first cleavage mitosis, showing typical centrosomes (egg of *Ascaris*, Professor Wilson's preparation).

Preparation V. Mitosis without chromosomes in a late blastula (egg of *Asterias*, unfertilized and etherized). In one of the blastomeres the aster is dividing, forming a typical central spindle but devoid of chromosomes.

Preparation VI. Cytasters (egg of *Asterias*, unfertilized and etherized). Many cytasters are found in the cytoplasm, some dividing, some forming synthetic triasters.

Preparation VII. Cytasters (egg of *Cerebratulus*, unfertilized and treated with a solution of calcium chloride). Many cytasters have appeared, the first polar mitosis being disturbed.

The Influence of Subcutaneous Injections, and of Instillations, of Adrenalin upon the Pupils of Frogs, with Demonstrations: S. J. Meltzer and Clara Meltzer Auer.

Many observers have established the fact that subcutaneous injections as well as instillations of adrenalin exert no influence upon the width of the pupil in normal mammals. In a series of experiments published recently by the authors of this report it was shown that from 24 to 48 hours after the removal of the superior cervical ganglion a subcutaneous injection or an instillation of adrenalin caused a considerable dilation of the pupil, which lasted an hour or longer.

In the present communication the authors report that in frogs a subcutaneous injection or an instillation of adrenalin into the conjunctival sac causes an unmistakable dilation of the pupils of a normal animal. The dilation lasts a good deal longer than was ever observed in mammals even after removal of the ganglion; after instillation some dilation may be perceptible as long as 36 hours. The maximum dilation may even continue as long as 12 hours.

When the cord is severed just below the medulla oblongata, the pupils usually become small and ellipsoid in shape. A subcutaneous injection causes them to become wide and round. Instillation has the same effect. Finally the effect of instillation can be well observed also on the excised eyes, even when the adrenalin is applied some hours after excision, provided the eyes are kept moist. The experiments were demonstrated.

William J. Gies,
Secretary.

THE TORREY BOTANICAL CLUB.

The meeting of April 12, 1904, was held at the New York College of Pharmacy, with Dr. MacDougal in the chair.

The first paper of the evening was by Professor L. M. Underwood on '*Cyathea* and its Allies in Jamaica.' One of the objects of Professor Underwood's trip to Jamaica last year was to study the tree ferns in the field. Specimens usually show a single pinna without its connections or any part of the caudex. Such material has been used for types and one species has been described from a single pinnule. Although a species which is well known can often be recognized by a fragment of a good specimen, it should show as much as possible of a pinna, its connection with the main rachis, and part of the caudex.

The Cyatheaceæ or tree ferns mostly have an elongated caudex or trunk, but a few are herbaceous. The more distinctive family characters are furnished by the sporangia, which are rounded-triangular with complete ring and are sessile or very shortly stalked. There are six genera in the West Indies distinguished by the character of the indusium, habit and cutting of the leaves.

Cyathea arborea is the oldest and best known of the West Indian tree ferns and the only one common to most of the islands, many of the species being found only on the islands on which they were originally described. It occurs at an elevation of 1,000 to 2,000 feet and forms a handsome tree with a spread of 14 to 18 feet. Above this it is replaced by a similar but larger species of *Alsophila*. *Cyathea arborea* and *C. elegans* are noticeably distinguishable by the caudex, that of the former being smooth, while that of the latter is very rough and shaggy. *C. nigrescens* is common to Jamaica and Cuba. *C. insignis* is a handsome plant, but as only two were seen, and these represented perhaps 200 years' growth, they were not taken for specimens, but notes were made on the trunk characters. A fine specimen is in cultivation at the conservatory of the Botanical Garden brought up by Professor Earle. Of the sixteen species of *Cyathea* which are not doubtful, thirteen are endemic in Jamaica and three are known only from type specimens. The sharp prickles of these and other species secrete a poison and wounds from them are very painful, so that collecting on the steep hillsides is likely to be attended with considerable discomfort. The genus *Alsophila* has three species which are well known. *A. armata,* occurring at 4,000 to 5,000 feet elevation, has a usual height of 40 to 45 feet and is the most graceful plant of the island. It is armed only with weak bristles. *Alsophila aspera,* which is a lower

tree, has smooth leaves but prickly petioles. It occurs at about 1,500 feet elevation. Two of the species are endemic. *Hemitelia* has one species, described early in the last century, which is probably extinct, and two others very little known. A species of *Lophosoria* has a dense bloom on the under side of the leaves and is somewhat xerophytic in habit. It has merely a woody base.

Cnemidaria is distinguished by its habit and the cutting of its leaves. It has veins uniting near the midrib to form meshes.

Amphidesmium, from Trinidad and South America, differs from all other ferns in that the veins bear a second or even third sorus.

Most of the species discussed were illustrated by herbarium specimens and by portions of their trunks.

The second paper was by Dr. P. A. Rydberg, on 'The Flora of Northwest America.' A general discussion of the manuals available for the identification of the plants of different parts of the United States was given and a review of Mr. Howell's flora of the Columbia River region.

WILLIAM T. HORNE,
Secretary pro tem.

THE PSYCHOLOGICAL CLUB OF CORNELL UNIVERSITY.

THE session of 1904 has been devoted to the consideration of current theories of auditory sensation. The following papers have been read:

MR. H. C. STEVENS: 'The Helmholtz Theory.'

DR. J. W. BAIRD: 'The Facts of Auditory Sensation.'

MR. C. E. FERREE: 'The Physics of the Ear.'

MR. C. E. GALLOWAY: 'The Histology of the Ear.'

MR. C. E. GALLOWAY: 'The Physiology of the Ear.'

PROFESSOR E. B. TITCHENER: 'Rutherford's Theory and its Relation to the Helmholtz Theory.'

PROFESSOR I. M. BENTLEY: 'Ebbinghaus and Stumpf.'

MR. G. H. SABINE: 'Max Meyer.'

DR. T. DE LAGUNA: 'Ter Kuile's Theory.'

MISS A. JENKINS: 'Ayers's Theory.'

PROFESSOR TITCHENER: 'The Theories of Gray and Wundt.'

MISS E. MURRAY: 'Hermann and Ewald.'

MR. STEVENS: 'Objections to the Helmholtz Theory.'

PROFESSOR BENTLEY: 'Is Analysis Possible without Resonators?'

DISCUSSION AND CORRESPONDENCE.

KINDERGARTEN SCIENCE.

DR. THEODORE GILL'S arraignment in SCIENCE (No. 488) of popular writers on natural history who indulge in 'baby talk,' by which is meant the practise of 'talking down' to an assumed inferior level of understanding, is a point exceedingly well taken. The use of a 'trot' to enable the young idea to canter smoothly along the road to learning, and thus avoid the toilsome march, is as much to be deprecated in natural science as in classics or other studies.

Dr. Gill's censure happens in this instance to be directed against over-popularizers of paleontology, whose administration of sugar-coated tabloids to juvenile readers is objected to on the ground, as he puts it, that 'science is scarcely food for babies.' But paleontological writers are not the only offenders in this direction. For the employment of kindergarten methods of illustration, even in serious articles, no science can compare with physiography. The recent literature of this subject has been suffering from a mania for interpreting topographic features in terms of vital phenomena, and for correlating, or attempting to correlate, physical changes (*cycle* is a misnomer) with stages of organic development. *Youth, maturity* and *old age* are terms constantly employed for indicating the successive expressions of unchanging forces in nature, for things as essentially different from life as the growth of the crystal is different from the growth of the individual.

It may be answered that an analogy is not implied by the use of these terms in a figurative sense, or if one is suggested, it is not harmful. Harmful it does become, however, when a false analogy is strained so far as to produce senseless or even ludicrous incongruities. Without exaggerating the prevailing style of metaphor, it may be said that a coordinate value is placed by physiographers upon the ridges and valleys of landscapes, and

the like-named structures in horses' teeth. They profess ability to examine a river's mouth and tell as shrewdly as any veterinarian whether the animated stream belongs to the colt stage, the four-year-old, or the decrepit old equine condition. To the discerning eye even pathologic conditions are revealed, for has not one writer described a stream with 'blind staggers'? Let any one cast a glance over the recent literature, if one suspects the simile overdone, and note, amongst other things, the surprising array of anthropomorphic conceptions of nature. Take even a master-craftsman like Professor Davis, originator, if I mistake not, of the terms 'pirate stream,' 'captured tributaries,' 'drowned valleys,' etc. (the hybrid 'peneplain' belongs to another story)—has he not said of Greece that it 'is a country standing up to its knees in the Mediterranean'? The fact may be literally true, but it is hardly decorous to specify anatomical particulars.

Another writer who believes in the virtue of parables characterizes a rapidly eroded land-surface as a 'precocious infant,' from which the lay reader may surmise that it has just graduated from kilts. But for delightfully refreshing imagery we must refer to a short article on 'The Aggrading Bar,' which appeared in these columns some little time ago (SCIENCE, V., p. 646), and begins as follows:

> "The little wriggling bar staggering blindly along in a broad meandering valley is like a small boy attempting to fill his grandfather's boots. The waste supplied from the side of the hills of the adolescent valley, cut by the ancestor of the present stream, is much too great a load for a little brook."

Here the anthropomorphic suggestion is very skilfully rendered, in fact so realistically that the fate of this inebriate little brook, after taking on its load at the aggrading bar, might almost be said 'to point a moral or adorn a tale.' As class-room illustrations, or as intending to impart instruction by means of allegory, figurative descriptions of this nature may, perhaps, be tolerated, but it is gratuitous to suppose that the method of Æsop is better adapted to the needs of readers of SCIENCE than the method of Zadig. Sully Prudhomme, in his essay 'On the Nature of Things,' makes some pointed remarks on the habit personifying inanimate nature, which it may be well for physiographers to take to heart.

Other illustrations of the kindergarten method might be given, but it is probably unnecessary to prove that the standard of most of our popular scientific magazines has become lowered through the habit of 'talking down' to average readers, instead of raised by talking just a little over their heads. Let it be asked as a general question which style of writing is the more helpful to students, that which assumes too much on their part, or too little? Does not there come a time in the education of youth when suggestion by means of nursery methods ceases to be a virtue? When a student reaches the point where he may be expected to dig for himself, let us put a spade into his hand, taking care, however, to call it a spade, and not a toy for making mud-pies.

C. R. EASTMAN.

HARVARD UNIVERSITY.

'VEGETABLE BALLS.'

REGARDING the subject of 'Vegetable Balls' the following additional information may be worthy of note. This curious formation is characteristic of the section Ægagropila of the genus *Cladophora* and is mentioned in Engler and Prantl's 'Die Naturlichen Pflanzenfamilien,' De Ionis 'Sylloge Algarum' and Hanck's 'Meeresalgen.' The most recent work on the subject seems to be that of C. Wesenberg on *Ægagropila Sauteri* (Overs. k. dansk. Vidensk. Selsk. Forh., II., 1903, pp. 168–203), of which there is a very good summary in *Jour. Roy. Micr. Soc.*, April, 1904. The alga occurs in Lake Sorö, Denmark, and the balls attain the size of the fist or of a child's head.

J. ADAMS.

ROYAL COLLEGE OF SCIENCE, DUBLIN,
June 29, 1904.

A NOTABLE PALEOBOTANICAL DISCOVERY.

TO THE EDITOR OF SCIENCE: Inasmuch as a note by the undersigned, entitled 'A Notable Paleobotanical Discovery,' in SCIENCE of July 8, was delayed in publication it is only just

to the writer to state that the article in question was written last January, before the final results of Professors Oliver and Scott had reached me, and that the footnotes which called attention to the later discoveries were added in April, when I read the proof.

With regard to the statement in the opening paragraph that the term Cycadofilicales was destined to become a permanent acquisition to taxonomy, I had in mind rather the idea that botanists would henceforward be unable to dispute the existence of paleozoic plants intermediate between the Pteridophyta and the Gymnosperms, rather than the question of terminology, and hence did not notice this slip of expression in a paper which further on mentions a new and vastly more appropriate name for the group in question.

EDWARD W. BERRY.

PASSAIC, N. J.

SPECIAL ARTICLES.

EVOLUTION AND PHYSICS.

EMINENT British biologists have recently visited severe criticisms* upon Lord Kelvin for giving voice to the opinion that evolution lies beyond the borders of physics and chemistry. The zeal with which they have hastened to the defense of current mechanical hypotheses of evolution apparently causes them to forget that it is exactly these physical conceptions with which Lord Kelvin may be supposed to be qualified to deal. And when Lord Kelvin admits that the 'forces,' 'principles,' 'energies' or other abstractions in use among physicists are not adequate for even a formal explanation of such biological phenomena as evolution, he states what is well-nigh axiomatic to some, and reaches a point of view appreciated by rapidly increasing numbers of biologists.†

The idea that there are biological phenomena essentially different from those of physics and chemistry has nothing to do with the theory of 'vital force' of half a century ago. It does not overlook the vast amount of physics and chemistry already found in plants and animals, nor the probability that multitudes of similar facts remain to be discovered. To argue, however, from the progress of knowledge in these directions that all the phenomena of organic existence are to be explained in current physical terms is to imitate the balloonist who reasoned that he would be able to see all the way around the earth if he could only go high enough.

It is entirely possible, of course, to range organic evolution under chemistry or physics, but at present it seems not to assort well with the other phenomena treated in these sciences. The difference appears to be, furthermore, not merely one of degree, but of kind, so that it may well be asked whether it is not more scientific for Lord Kelvin to recognize and admit such a distinction, even though it may prove ultimately to have rested on a present limitation of knowledge, than for his critics to insist on the identity of phenomena between which no indication of relationship has been shown. At least we must expect that the unprejudiced layman will think it quite as possible that the biologists have been indulging in bad physics as that Lord Kelvin is totally in error with regard to the rôle of physical forces in biology. The outsider might even wonder why the eminent specialists from the two branches of knowledge are not organized as a joint committee to consider whether their fundamental conceptions are the same or not, instead of wasting time in mutual recriminations of ignorance. In the scientific world, such charges can not, of course, go amiss, but conscious ignorance is better than unsupported assertion.

Whether the formation of crystals should be called fortuitous or not is another question of words; it will hardly be insisted that it is a completely fortuitous 'concourse of atoms' which makes crystals of regular form from a solution stirred up in a beaker; to cover our ignorance we ascribe to some substances a special property named crystallization. If protoplasm could be obtained from a similar dissolved mixture of its ingredients, this would be ascribed by parity of ignorance and logic to 'plasmatization' or whatever such a prop-

* SCIENCE, N. S., XVIII., 138, July 31, 1903.

† See, for example, 'A Text-book of Botany,' by Strasburger, Schenck, Noll and Schimper, p. 158, London, 1903.

erty might be called. But such a discovery would not end the physico-biological controversy, nor have any serious effect upon it, since we know already that the 'chemical compound' termed protoplasm, however originated, has numerous activities not shared by other compounds, and explainable only by the predication of numerous thus far unexplained properties, such as assimilation, growth, irritability, reproduction, etc.

The biochemist hopes to make protoplasm in a beaker, but in transforming his homogeneous jelly into a 'sprig of moss' he will need to utilize agencies not only unexplained, but not even analogous to the postulates or properties now ascribed to unorganized matter. These agencies or properties of life are doubtless as 'natural' as those treated in physics and chemistry, but they are different. To call them 'creative' or 'directive' is, perhaps, open to objection, but they are certainly conservative, coordinative and constructive in a manner and degree for which we have no extravital analogy. The directive idea, however, is by no means extinct among biologists. Naegeli's '*Vervolkommungsprincip*' has been succeeded by an equally hypothetical 'mechanism of heredity' which Professor Weismann and his numerous followers are still seeking in germ-cells. It is possible, however, to frame an evolutionary theory without recourse either to 'phyletic vital force' or to incredibly complicated and yet inadequate mechanical determinants.*

It is needless to fear that Lord Kelvin will destroy the fact of organic evolution established by Darwin, but, on the other hand, no amount of argument can rehabilitate Darwin's first theory of the developmental process, that the environment causes variations and then selects the desirable changes. This view was abandoned by Darwin himself, and is now held in its original logical integrity by very few working biologists, the non-inheritance of acquired characters having rendered it untenable. The present multiplicity of theories of development is a sufficient indication that there is, as yet, no generally accepted explanation of evolution or of the other characteristic properties of life, and no 'complete mechanical theory of the universe.' Lord Kelvin will perform an important service for biologists if he encourages them to attempt an adequate formulation of the ascertained facts of their own science instead of thinking it necessary to base their structure on terms and concepts borrowed from widely separate fields of research.

The Vocabulary of Science.—The interest of such a discussion as that precipitated by Lord Kelvin is not confined to the varied opinions advanced; it furnishes also an excellent example of the more general and fundamental fact that the 'advancement of science' depends quite as much upon expression as upon investigation. This is true not merely because it is necessary to frame intelligible statements of scientific results which are to be of practical use, but because investigation itself can not advance far beyond the language in which its results must be interpreted. The rational arrangement or classification of facts is supposed to distinguish the methods and discoveries of science from those of mere accident and empiricism.

As soon as they leave concrete data and distinctions, scientific men fall to dogmatizing like any other theologians, metaphysicians or philosophers. This is not, however, because of any special inconsistency or weakness, but because all are at the mercy of an inadequate vocabulary and can say only what has been said already, or something sufficiently similar to require a new word only now and then. On the borders of knowledge each word does duty for a great variety of ideas, and the same proposition often conceals essential diversity of thought. The less known about a subject the easier to dogmatize, or to formulate and establish a vocabulary, and an established vocabulary is a fact to be reckoned with as much as any other.

Science and general literature are thus forever at war because, while comprehension advances from the concrete and particular to the general, the language in which ideas must be

* 'A Kinetic Theory of Evolution,' SCIENCE, N. S., XIII., 969, June 21, 1901; 'Stages of Vital Motion,' *The Popular Science Monthly*, LXIII., 14, May, 1903.

formulated often develops in the contrary direction, from the abstract to the concrete. Generalizations built of facts are not abstractions, but collective facts, while the words in which they are expressed nearly always trace their origins back to primitive abstractions. 'Force' was originally a mere synonym of 'strength,' but has now become, in the minds of many, a physical entity, and 'heredity' or 'heirship' is actualized into a determining 'principle' of evolution. Philosophy came before science, metaphysics before physics and physics before biology, in the history of progress from the abstract to the concrete. The phenomena of personality are most familiar, but they have received the slightest scientific attention; in the phenomena of life we also participate, but have only begun to generalize, while the phenomena and theories of unorganized matter are formulated almost as extensively as those of metaphysics, and with the assistance of as many abstractions. Recent discussions of the constitution of matter read like metaphysical treatises, lacking only a certain ponderous assumption of certitude. The idealistic physicists argue that matter is electrical, while the materialists suspect that electricity may be material.

Forces and Properties.—In dealing with unorganized matter the physicist has an apparent advantage over the biologist, since he is able to command definite quantities and uniform materials and conditions of experiment, and thus secures results which can be stated in mathematical form, but this has not given him, as yet, an adequate insight into the nature and causal relations of the phenomena with which he deals. It is not the physicists who are attempting to extend their practice into biology, but the biologists who insist on paying tribute to physics, even after such an eminent specialist as Lord Kelvin has pronounced their case hopeless, unless recourse be had to other 'forces' than those at his professional command.

Physicists are willing to recommend 'vital principle' as an aid in biological difficulties because similar 'hypothetical entities' are much used to assist in the formulation of physical facts. That 'vital force' does not really explain anything is no objection to it from the physical standpoint; neither do other 'force' abstractions. Their function is merely to assist the mind to follow ascertained sequences of facts; they are our algebraic substitutes for unknown causal connections. As soon as we thoroughly understand the mechanism, the instinct of causality is satisfied and the hypothetical 'force' becomes superfluous; it is useful only if it assists observation and experiment. The old vital force which 'terribly hampered' biological investigation was a thoroughly bad abstraction, and has been consigned to a merited oblivion. The unwillingness of biologists to restore this idol or to set up another in its place should not, however, lead them to ascribe any superior virtue to the gods of the physicists, unequally doomed to dethronement.

Physicians have long since given over general theories of disease and are reconciled to treating symptoms and removing causes. When other branches of science have received a similar amount of study they may be content with phenomena and leave the 'entities' to the metaphysicians. Phenomena, instead of being assigned to unknown entities, are more conveniently and practically classified into groups called properties, and in biology we are ready to give up the notion that each property or group of phenomena must have a 'force' or other hypothetical entity behind it. The perception has come that the properties of life are not distinct 'forces,' but are merely different aspects of the same vital process. It is as a process rather than as a 'force' that life appears to lie beyond the phenomena of physics.

It did not improve matters to analyze evolution into two hypothetical opposing 'forces,' heredity and variation, or heredity and environment; these abstractions have long concealed the universal facts that organisms follow each other in series of similar but not identical individuals, and that species are not merely influenced by environment, but are normally in motion. There is no heredity which keeps organisms exactly alike, nor any

environment in which they will remain so.* The chief effect of these abstractions is to breed others as hypothetical as themselves. The facts are very simple, the abstractions become vastly complicated. Biologists are zealous for mechanical theories of their own making, but when Lord Kelvin fails to recognize these as adequate from the physical point of view and offers a 'vital principle' instead, the gift is rejected without thanks, and with the ungracious reply that it is a cast-off notion which ceased to be useful many years ago.

If evolution is ever explained in physical terms it will probably be done by making generous additions to the recognized properties of matter, a course to which physicists are certainly nothing loth, but they are duly warned by Professor Lankester that such 'facile and sterile hypotheses' will not satisfy biologists. Indeed, it may be that the failure to recognize a distinct category of vital phenomena lies not so much in what might be called a materialization of life as in a certain vitalization of matter. We predicate for matter our own mechanical limitations and refuse to consider such a possibility as the interaction or mutual sensitiveness of matter through space, although the alternative theories of ethereal media are extremely complicated and contradictory.

Comprehension versus Formulation.—Physics is considered fundamental to biology because organisms are made of matter, but biology is in advance of physics in the apprehension of its phenomena, and we are as likely to learn physics from biology as biology from physics. Life is, as it were, superposed on matter, and personality on life; each must have the qualities which make the next stage possible, but each stage may be viewed also on a plane of its own, and our intimate acquaintance with phenomena has not gone up from the bottom of the pyramid, but from the top down. The ultimate facts of matter appear fundamental from the mechanical standpoint, but the fabric of knowledge has been constructed thus far without them, and science must continue to advance laboriously from the known to the unknown. It may be illogical to discover the basal facts last, but such is the indication of history, to which it is well to be reconciled.

Every-day objects and incidents are the last to secure critical study and scientific elucidation; it is the obscure and incomprehensible which challenges our curiosity. Primitive man seems to have taken interest first in dreams and specters. Astronomy, as incidental to astrology, was the earliest of the physical sciences, and still owes much of its popularity to the instinctive attraction of mystery and awe. With mental habits and instincts formed by such a history it is not strange that thought still travels unwillingly from the remote and abstract to the concrete and adjacent, and that even in science we are continually tempted to value formulation above concrete perception, and to confuse abstraction with generalization. The cabala is discarded and the syllogism is distrusted; in time it will become apparent that even the mathematical equation yields only the amount of comprehension originally put into it, and has no virtue beyond any other method of accurate statement. The 'complete mechanical theory of the universe' is not yet, nor is its completion to be hastened by eking out the hewn stones of ascertained fact with blocks of the dried mud of abstraction. Such material may be very useful in temporary shelters for the workmen, but it has no place in the permanent structure.

A General Classification of Phenomena.—Although abstractions and 'hypothetical entities' must be excluded from among the results of scientific study, there is still great need of general terms as a means of arranging ideas and classifying facts. It is here that biology may possibly aid her sister sciences, since biological classification is more concrete than any other, being based on ascertained causal sequence or common descent. Other classifications are of value in proportion as

*" * * * the *law of heredity,* would, if nothing interfered, keep the descendants perfectly true to the physical characters of their ancestors; they would breed true and be exactly alike."—*Coues.*

"Were it possible for growth to take place under absolutely constant external influences, variation would not occur. * * *"—*Weismann.*

they serve a similar purpose. When the causal relations are prominent the analogy with biology may be close; in other instances the resemblance is only formal; the categories or grand divisions become mere abstractions, and the resulting association of facts follows no natural sequence. Philosophers who have sought to frame ultimate classifications have largely neglected to take advantage of the concrete basis of arrangement afforded by the coherence of the biological series.

To integrate everything to the unity of a single 'substance' or 'principle' (monism) is an idealization of mathematical concepts for which no objective reasons have been adduced. Matter, life and person* appear, as yet, to be final categories of phenomena, comprising different series of properties and meriting separate vocabularies. The second and third categories are not, it is true, independent of the first or of each other, but no causal nexus has been established. Matter gives us elsewhere no hint of the power of vital coordination, and consciousness is no necessary part or consequence of biological evolution. The materialist defines matter so as to include the other categories, while the idealist would annex the universe to the realm of thought. From the middle ground of biology it is apparent that such assumptions are devoid of practical meaning, in that they correspond to no perception based on objective experience. It is easy to say 'protoplasm is a chemical compound' or 'matter thinks,' but these integrations are born of the confusion of words rather than of the conception of ascertained facts. The chemist will find that protoplasm is not a single compound, but an ever-varying infinity of compounds, each capable of work of which 'unorganized' matter has given no suggestion. Neither is it necessary to confuse deliberate purpose with chemical affinity or physical reaction, in the vain attempt at the construction of a specious universal equation.

Students of nature have labored mightily, and they must also wait patiently. Science is advanced neither by disconnected particulars nor by meaningless generalities; all possible associations of facts are to be considered, but essential distinctions must not be neglected and the unlike confused. To recognize biological phenomena as distinct from those of physics does not require belief in an intermittent creation or a polytheistic theology, as suggested by Professor Lankester; the diversity is not lessened by ascribing it to gradual changes which both the physical conditions and the organisms have experienced 'since life began,' whatever that may mean. And until we know vastly more than we do about life and matter, nothing is to be gained by confusing either the phenomena or the vocabularies of biology and physics. Science observes, classifies and interprets facts, with the assistance of language, but neither facts nor words are science by themselves.

O. F. COOK.

WASHINGTON, D. C.
October 16, 1903.

* As a designation for the third category of phenomena this term, though open to many objections, seems preferable to consciousness, as being at once more general and more particular. Consciousness is a property of person as inertia is a property of matter and evolution a property of life; in this sense consciousness does not become synonymous with intelligence, memory, instinct or mere protoplasmic irritability, as sometimes implied by Minot and other biological writers. Instincts, and even mental arts, such as language, are attainable without subjective intelligence or deliberate thought.

AGRICULTURAL EXHIBITS AT ST. LOUIS.

A PAMPHLET has been issued containing a description of the collective exhibit of the colleges of agriculture and mechanic arts and the agricultural experiment stations of the United States in the Palace of Education at the Louisiana Purchase Exposition. The exhibit, as the pamphlet explains, is intended to illustrate the progress of education and research in agriculture and the mechanic arts in the United States, showing those distinctive features of the work of the land-grant colleges and experiment stations which differentiate them from other educational and scientific institutions. It is probably the most complete and comprehensive display of its kind that has ever been attempted and is believed

to furnish an instructive exposition of a phase of educational and scientific effort which is rapidly extending and is already exerting a potential influence in developing the industries and resources of the country. It is safe to say that in no special field of education and research has there been greater progress during the past decade than along the agricultural, industrial and technological lines represented by the land-grant colleges and experiment stations. The exhibit is under the control of the Government Board, and has been prepared under the general management of a committee of the Association of American Agricultural Colleges and Experiment Stations, of which Dr. W. H. Jordan, director of the New York Experiment Station, is chairman. Mr. James L. Farmer, special agent of the Government Board, is in immediate charge. The exhibit occupies about 16,000 square feet of space very favorably located in the Palace of Education. In addition to the displays of the U. S. Bureau of Education and of the Office of Experiment Stations of the U. S. Department of Agriculture, which represent the national government in its relations with these colleges and stations, the space devoted to agricultural exhibits is divided into fifteen sections, that occupied by the mechanic arts exhibits into nine sections. The displays in these sections have been prepared with the collaboration of experts selected from the faculties of the land-grant institutions, agricultural experiment stations and the U. S. Department of Agriculture, and cover all of the principal subdivisions of agriculture and mechanic arts.

The agricultural exhibits include soils, fertilizers, plant laboratory, field crops, horticulture and forestry, plant pathology, economic entomology, classed under the general head of agronomy or plant production; animal husbandry (investigation), animal husbandry (instruction), and veterinary medicine, classed under the head of zootechny or animal industry; dairy laboratory and sugar laboratory, classed under the head of agrotechny or agricultural technology; rural engineering, or farm mechanics; rural economics or farm management; and inspection. The mechanic arts exhibits include civil engineering, mechanical engineering, electrical engineering, mining engineering, technical chemistry, architecture, drawing and shop practise (including textiles and trades), domestic science and ceramics.

HONORARY DEGREES CONFERRED BY THE UNIVERSITY OF WISCONSIN.

On the occasion of the recent jubilee celebration of the University of Wisconsin, the doctorate of laws was conferred on some forty delegates. The words addressed by President Van Hise to several of the candidates were as follows:

Henry Prentice Armsby—Formerly professor at this university, with the aid of ingeniously devised apparatus you have for years been successfully working upon the very important problems of metabolism of food nutrients. Upon you, for these valuable researches on the nourishment of the body, and for vigorous administration of the Pennsylvania state agricultural experiment station, we confer the degree of doctor of laws.

Thomas Chrowder Chamberlin—It is with the greatest pleasure that I confer upon you the degree of doctor of laws. The University of Wisconsin owes you much. As her president for five years, you contributed to her development and upbuilding more than can be estimated. She honors you to-day for this, and also for your contributions to the science of geology. In your work in connection with the state and federal surveys, and in your comprehensive scientific investigations regarding the principles of ore deposition, the Pleistocene formations and the evolution of the solar system, you have combined in a rare manner patient collections of facts, discriminating reasoning power and constructive scientific imagination. You have richly deserved the highest academic honor in the gift of this university.

John Dewey—Profound philosopher and psychologist, you have successfully applied your learning to the study of childhood and youth. You have been an inspiration and a guide to students of education in every progressive country. For distinguished service

in the development of educational theory and practise this university confers upon you its degree of doctor of laws.

WILLIAM GILSON FARLOW—For your fundamental contributions to the morphology and classification of cryptogamic plants, in which you have advanced our knowledge of the evolution of plant life; for your valuable studies in applied botany, and because of your distinction as a representative of all botanical enterprises of international scope, the University of Wisconsin confers on you the degree of doctor of laws.

GROVE KARL GILBERT—Deep interpreter of nature, scientist of balanced judgment, geologist of the first rank, preeminent in the development of physiography; upon you, especially for the masterly formulation of the principles of erosion, by the authority of the regents I confer the degree of doctor of laws.

FRANKLIN PAINE MALL—Foremost investigator in anatomy in America, leader in recent advance in medical education, you have established productive departments of anatomy in three universities. Your teaching has inspired a strong group of disciples doing important work at this and other universities. You are well worthy the honor of all, for your aim is to decrease human suffering. This university, therefore, confers upon you the degree of doctor of laws.

EDWARD LAURENS MARK—This university confers upon you the degree of doctor of laws in recognition of your profound researches upon embryology and the animal cell, and of your services, for more than a quarter of a century, as the head of a great laboratory in which many of the zoologists of this country have been trained in the methods of fruitful research and inspired with the highest ideals of their science.

ELIAKIM HASTINGS MOORE—Teacher stimulating the study of the higher mathematics in America; leader accomplishing much for the betterment of mathematical instruction in schools of all grades; mathematician, whose erudite labors and fruitful research in an ancient science have made the world your debtor, upon you, for mathematical investigations, by authority of the regents, I confer the degree of doctor of laws.

ALFRED NOBLE—I confer upon you the degree of doctor of laws on account of your eminence as an engineer, a scientist and a man of affairs. Your skill in large construction, your broad views and sound judgment, and your knowledge of applied science, have made you an eminent expert and enabled you to make important contributions to the solution of the great problems of transportation.

SAMUEL LEWIS PENFIELD—Your determination of the molecular structure of complex minerals and researches upon the relation of crystal forms to chemical composition have advanced the knowledge of the constitution of matter. For determinative mineralogy you have written the authoritative text. Worthy successor of your illustrious predecessors Silliman and Dana, you have won fresh laurels in science for Yale University. In recognition of this work we confer upon you the degree of doctor of laws.

AUGUSTE RATEAU—In recognition of your achievements as a mechanical engineer, as a contributor to the science of the flow of fluids; as a distinguished inventor of steam turbine engines and as an author of standard books in engineering, upon the recommendation of the faculty, by the authority of the regents, I confer on you the degree of doctor of laws of the University of Wisconsin.

EDGAR FAHS SMITH—For pioneer work in the electrolytic separation of metals; for valuable researches upon the compounds of tungsten, molybdenum and uranium; for the training of a large number of scholars devoted to the advancement of the science of chemistry, this university confers upon you the degree of doctor of laws.

EDWARD BRADFORD TITCHENER—Through your skill in experimentation and your independence and sanity of judgment, you have become a leader in modern psychology. In many ways, and especially by your laboratory manual of experimental psychology, you have contributed to the creation of a new department of university study. For this work, the university confers upon you the degree of doctor of laws.

James Wilson—From the presidency of Iowa Agricultural College you were called to the cabinet by William McKinley. By President Roosevelt you were retained as the head of the United States Department of Agriculture. Under your solicitous care scientific work has risen to first place in the greatest bureau of agricultural research in the world. Upon you, for the encouragement and fostering of agricultural education and research, and thus helping to dignify the great fundamental vocation of agriculture, this university confers the degree of doctor of laws.

Robert Simpson Woodward—As a mathematician you have departed from the beaten paths and have applied your art with unusual power to new fields in the border-land between astronomy, geodesy and geology. In recognition of your important contributions to knowledge in this department of learning, the university confers upon you its honorary degree of doctor of laws and welcomes you to its fellowship.

SCIENTIFIC NOTES AND NEWS.

Dr. W. H. Maxwell, superintendent of schools in New York City, has been elected president of the National Educational Association.

The honor of knighthood has been conferred on Professor James Dewar by King Edward.

Professor Robert Koch has been elected a member of the Berlin Academy of Sciences, filling the vacancy caused by the death of Professor Virchow.

Oxford University proposes to confer the degree of D.Sc., *honoris causa,* upon the following persons, on the occasion of the visit of the British Medical Association: Thomas Clifford Allbutt, M.D., F.R.S., regius professor of physics at Cambridge; Andrew Clark, F.R.C.S., vice-president and chairman of the council of the British Medical Association; Thomas Dryslwyn Griffiths, M.D., president of the British Medical Association; Jonathan Hutchinson, F.R.S., late president of the Royal College of Surgeons; Sir William Macewen, M.D., F.R.S., regius professor of surgery in the University of Glasgow; Sir Patrick Manson, K.C.M.G., M.D., F.R.S.; Sir John William Moore, M.D., late president of the Royal College of Physicians of Ireland; William Osler, M.D., F.R.S., professor of medicine at Johns Hopkins University, Baltimore; Thomas George Roddick, M.D., M.P. (Canada), late president of the British Medical Association.

Dublin University has conferred its honorary doctorate of science on Mr. Philip Watts, Sir James Dewar, Mr. Jethro J. Harris Teall and Dr. William Henry Thompson.

Mr. William H. Nichols, president of the General Chemical Company and of the Nichols Chemical Company, has received the doctorate of laws from Lafayette College. Dr. Nichols has also been nominated by the council of the Society of Chemical Industry, to succeed Professor Ramsay as president.

Sir William Ramsay, Sir Henry Roscoe and Professor Landolt have been elected honorary members of the German Bunsen Society.

Sir Francis Sharp Powell has been elected president of the Royal Statistical Society.

The General Assembly of the State of Maryland voted, at its recent session, a gold medal to Colonel Charles Chaillé-Long, in recognition of his contribution to the solution of the Nile problem by the discovery of Lake Ibrahim in 1874 and his services to humanity rendered at the time of the bombardment of Alexandria in 1882.

The Franklin Institute, Philadelphia, will confer the Elliott-Cresson medal on Dr. Hans Goldschmidt in Essen-Ruhr, Germany, in recognition of his distinguished work in aluminothermics.

We learn from *Nature* that the French Society of Civil Engineers has this year awarded its prizes as follows: the annual prize to M. J. Bernard for his work on the installation in the Red Sea of three lighthouses in circumstances of especial difficulty. The Michel Alcan prize was awarded to M. L. Guillet for his researches on the composition of steel, and the F. Coignet prize went to M. V. Picou for his work on the regulation of dynamos. A prize was awarded to Professor

E. Hospitalier for his works on the study of phenomena which by their rapidity and frequency baffle ordinary methods of analysis.

MR. H. C. RUSSELL, government astronomer of New South Wales, will retire at the end of the present year, after a service of forty-six years.

DR. A. P. LUFF has resigned his appointment as scientific analyst to the Home Office of the British government. Dr. W. H. Wilcox has been recommended by the Council of the Royal College of Surgeons of England, as his successor.

DR. JOHN BELL HATCHER, curator of vertebrate zoology at the Carnegie Museum, Pittsburg, died on July 4 from typhoid fever, at the age of forty-six years.

WE regret to record the death of M. Anatole de Barthélemy, the eminent French archeologist, at the age of eighty-three years; of Dr. W. Weiss, professor of mathematics at the German Technological Institute of Prague, on June 18, at the age of forty-five years; of Dr. V. Merz, formerly professor of chemistry at Zurich; of Dr. Gilles de la Tourette, the well-known French alienist; of Mr. Edward Trimmer, for thirty-six years secretary of the Royal College of Surgeons, England; and of Lieutenant-General Dubrovin, who was for a long time secretary of the Imperial Academy of Sciences at St. Petersburg.

THE *Geographical Magazine* states that the Russian Geographical Society, with the aid of money subscribed by a private person, is organizing a new expedition for the exploration of the northern coasts of Siberia, between the Yenisei and the Lena. The head of the expedition will be M. Tolmacheff, already known for his journeys and explorations in Russian Asia.

IN January, 1905, the Bombay branch of the Royal Asiatic Society proposes to celebrate the centenary of its foundation by a public gathering, at which papers will be read and an exhibition of the possessions of the society held.

THE International Astronomical Congress will meet at Lund, Sweden, beginning on September 5.

THE subject of the essays for the Howard medal of the Royal Statistical Society for 1905 will be 'A Critical Inquiry into the Comparative Prevalence of Lunacy and other Mental Defects in the United Kingdom during the last 50 years.'

A *conversazione* of the Institution of Electrical Engineers was held on June 28 in the Natural History Museum, London. The guests, who numbered about 1,500, were received by Mr. R. K. Gray, president, and Mr. Alexander Siemens, president-elect.

A CABLEGRAM to the daily papers from London, dated July 8, says that the annual report of the Cancer Research Fund was submitted at the third annual meeting. It stated that the investigations of the year had resulted in discoveries having an important bearing on several crucial problems in connection with the disease, knowledge of which had been greatly increased. Briefly and untechnically stated the new facts are that cancer pervades the whole civilized and uncivilized world. Hence it is not, as was supposed, a product of civilization. It affects animals as well as human beings, and also fishes. It attacks all subjects at relatively the same age. It is not infectious and is not transmissible from one species to another. The cancer cell can reacquire powers of self-propagation. Cancer is not attributable to a parasite. It is not increasing. Experiments have not shown that radium exercises a curative effect.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the death of Mrs. Susan W. Clark, Clark University will receive $400,000, left in trust for her use, and a further sum of $50,000 to $75,000 from her estate.

MR. JOHN D. ROCKEFELLER has given Denison Baptist University, Newark, Ohio, $100,000.

IT is reported that the Sheffield Scientific School, Yale University, will have a large en-

tering class. There were 326 freshmen last year, against 207 the previous year. The returns from the entrance examinations show that there were 730 candidates for admission to the school against 651 a year ago, an increase of 79. Of these there were 372 last June, a gain of 36. There was a similar increase in the candidates who took the preliminary papers. The number this year was 358 against 315 last year, a gain of 43.

Dr. Charles Schuchert, of the U. S. National Museum, has been appointed professor of historical geology in the Sheffield Scientific School of Yale University and curator of the geological collections in succession to the late Professor Beecher.

Dr. Dickinson S. Miller, instructor in philosophy in Harvard University, has been elected lecturer in philosophy at Columbia University.

Recent changes in the scientific faculty of the State University of Iowa are as follows: The department of physics has been divided, Professor A. A. Veblen retaining the chair of experimental physics, while Professor A. G. Smith has been transferred from the chair of mechanics in the department of mathematics to a new chair of physics and mechanics. Dr. R. T. Wells will continue to act as professor in charge of electrical and mechanical engineering. The chair of civil engineering, made vacant by the resignation of Professor A. V. Sims, will be filled before the opening of the coming academic year. Following the resignation of Dr. L. W. Andrews from the chair of chemistry in the college of liberal arts the reorganization of the work of instruction in this branch for the entire university has been assigned to Dr. E. W. Rockwood, heretofore professor of chemistry and toxicology in the colleges of medicine. An instructorship in metallurgy has been established which is yet to be filled. Additional instructors in mathematics and in mechanical drawing are also to be appointed.

The following additions have been made to the faculty in the scientific departments of the University of Kansas: H. D. Hess, of Lehigh University, 1896, has been elected associate professor of mechanical engineering and director of the Fowler shops; Albert K. Hubbard, Yale, 1901, assistant professor of civil engineering; George F. Kay, Ph.D. (Chicago, 1904), Toronto University, 1902, assistant professor of geology and mineralogy; Robert W. Curtis, Ph.D. (Yale, 1904), Trinity, 1896, assistant professor of chemistry; Wm. J. Baumgartner, Ph.D. (Chicago, 1904), University of Kansas, 1900, instructor in zoology; Charles G. Rogers, Ph.D. (California), instructor in physiology.

The following appointments were made in the medical faculty of the Johns Hopkins University: Dr. Percy M. Dawson, associate professor of physiology; Dr. Joseph Erlanger, associate professor of physiology; Dr. Warren H. Lewis, associate professor of anatomy; Dr. Arthur S. Lowenhart, associate in physiological chemistry and pharmacology; Ernest G. Martin, Ph.D., instructor in physiology; Dr. Augustus G. Pohlman, instructor in anatomy; and Dr. George L. Streeter, instructor in anatomy.

A fellowship is vacant in the Department of Chemistry, Ohio State University, Columbus, Ohio. The value of the fellowship is $300 and in addition the student is exempt from all fees. Applicants should apply to Professor William McPherson.

The Yale corporation has accepted the resignation of Professor George Trumbull Ladd, head of the department of mental philosophy and metaphysics.

Professor Des Coudres has been appointed director of the newly established laboratory for theoretical physics at Leipzig.

A new chemical laboratory has been dedicated at Karlsruhe which will be under the direction of Professor Engler.

Professor Krehl, of Tübingen, has been invited to the chair of medicine at Strassburg, left vacant by Professor Naunyn's retirement.

Dr. Jos. Wellstein, professor of mathematics at Giessen, has been called to Strassburg.